ATLAS NSW Trigger

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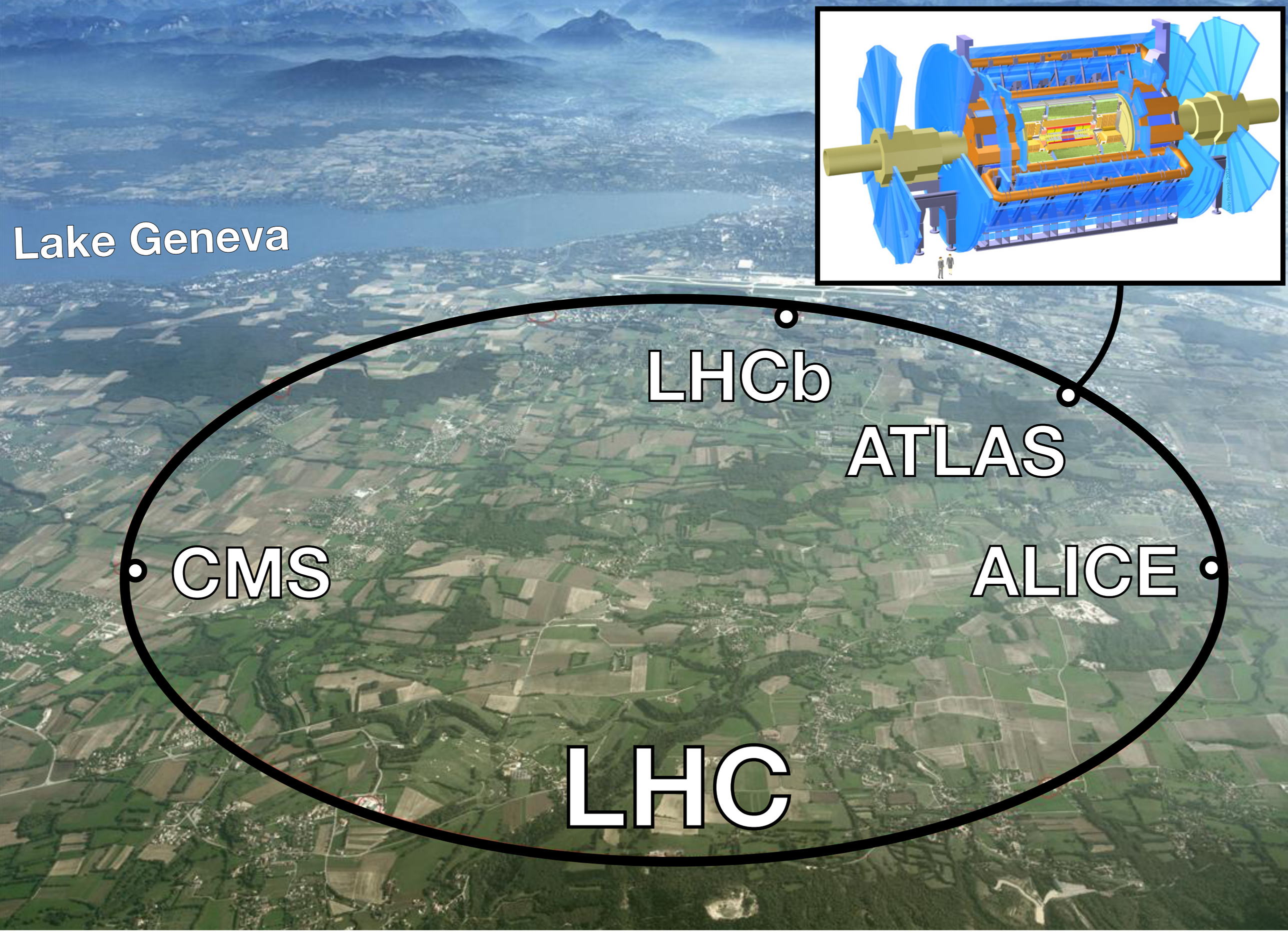
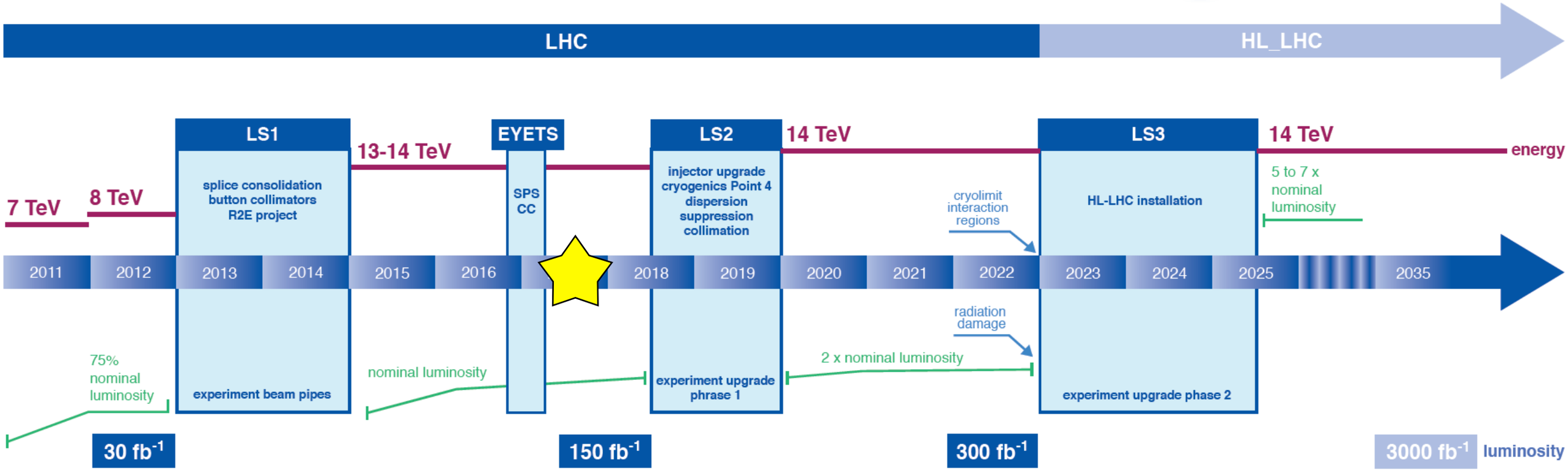
related talks this week

Yu: ATLAS MDTs for HL-LHC	Monday afternoon
Catrin: ATLAS trigger algs in Run 2	Monday afternoon
Heather: ATLAS trigger menu in Run 2	Monday afternoon
Tom: ATLAS Muon for HL-LHC	Wednesday afternoon
Xiangting: ATLAS tRPCs for Run 3+	Thursday morning
Liang: ATLAS NSW Electronics	**Thursday morning**
Jared: CMS GEM for Run 3+	**Thursday afternoon**

introduction


Lake Geneva
LHCb
ATLAS
CMS
ALICE
LHC

a 20-year plan for the LHC



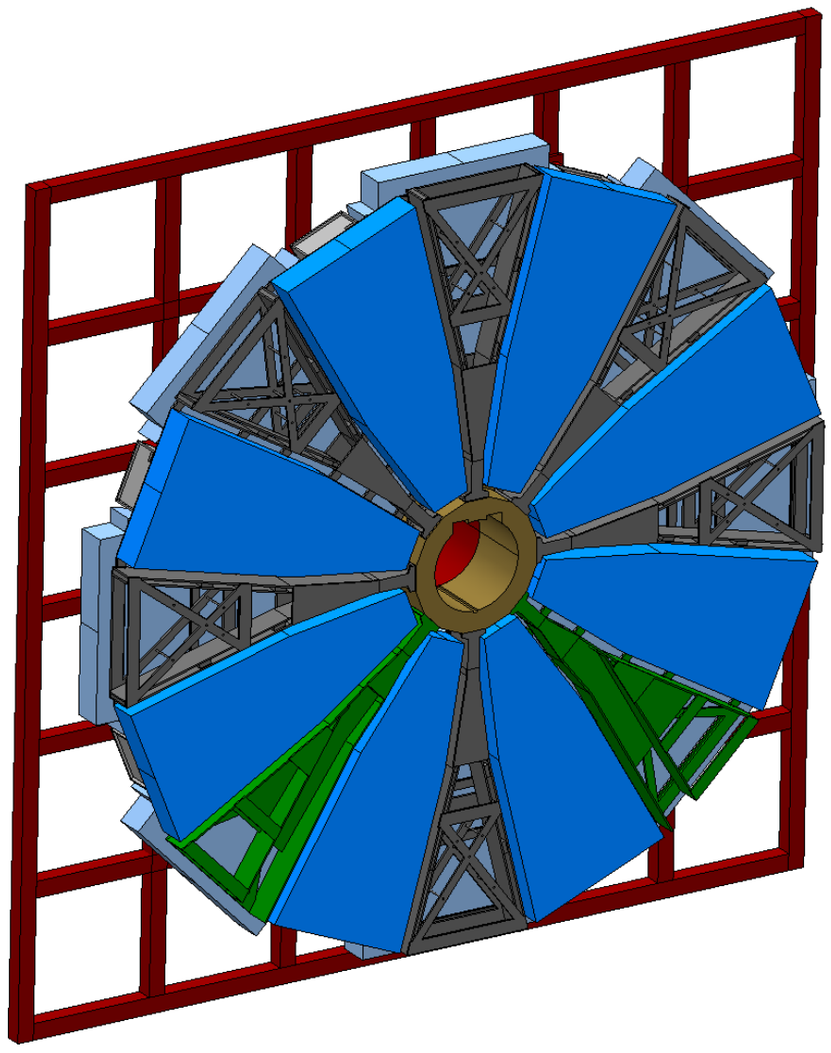
instantaneous luminosity increasing — experiments must adapt!

ATLAS has suite of upgrades for near-term (Phase 1)
and long-term (Phase 2)

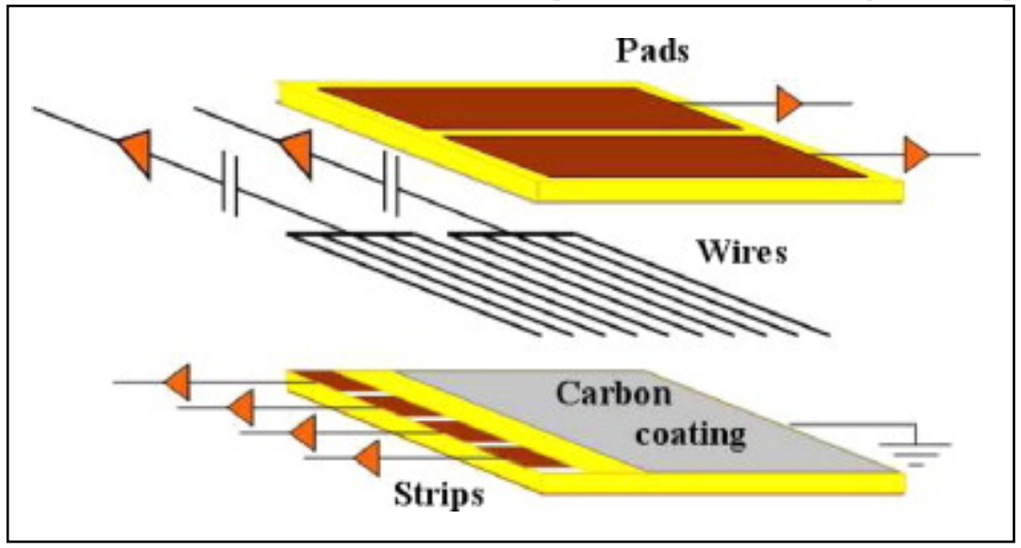
the new Small Wheel (NSW)

NSW replaces current SW —
under construction now

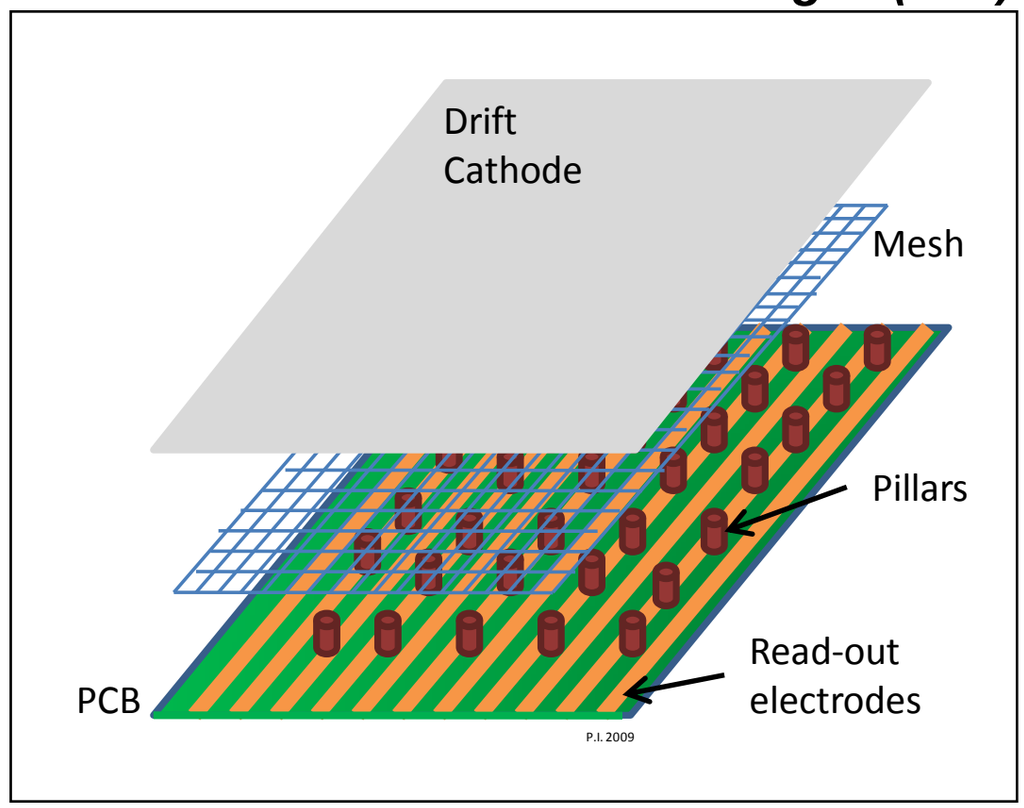
comprised of eight layers each
of two new detectors for ATLAS



small Thin Gap Chambers (sTGC)



Micromegas (MM)



the new Small Wheel (NSW)

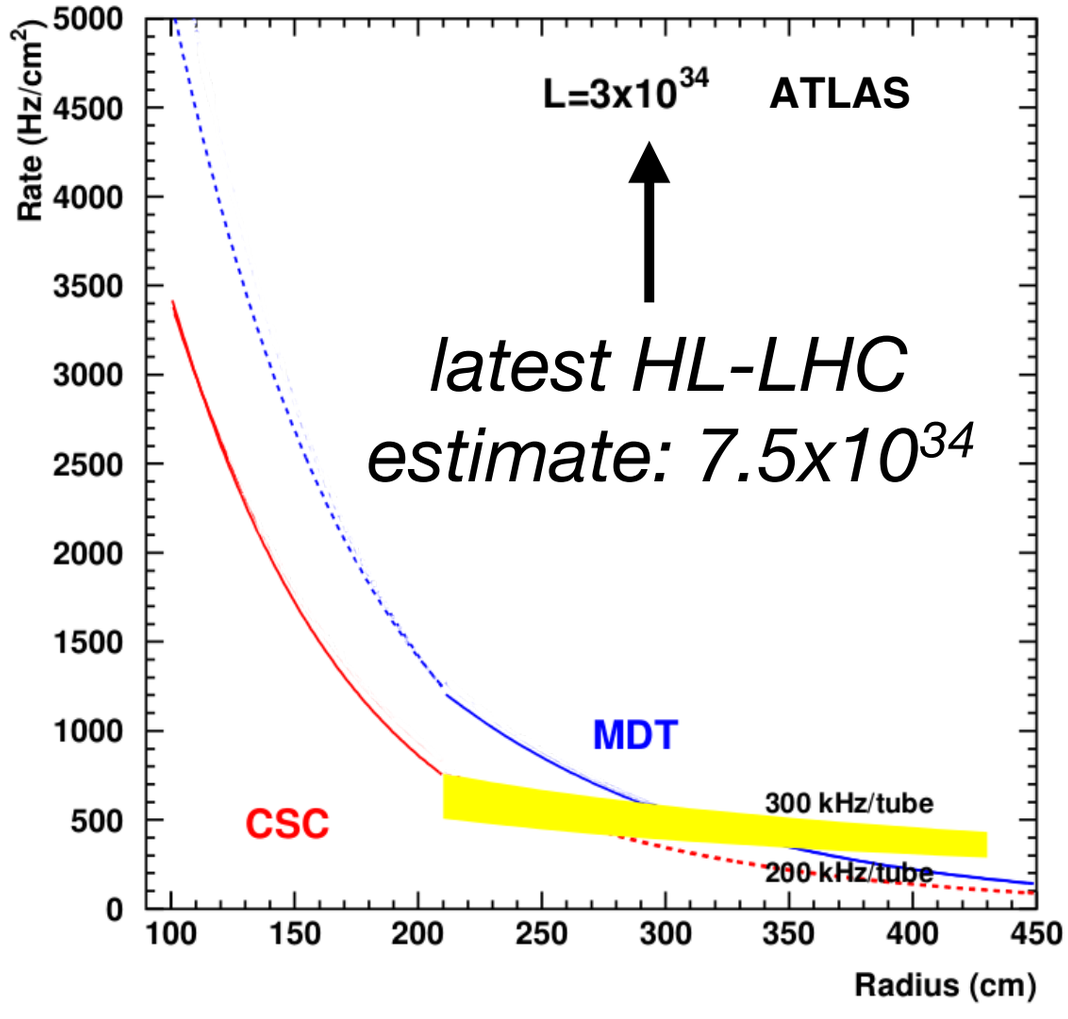
offers two major improvements to ATLAS muon spectrometry

rate capacity

detector elements much smaller in NSW than current SW

e.g. MM strip pitch ≈ 0.5 mm
whereas CSC strip pitch ≈ 5 mm

smaller flux per element @ NSW



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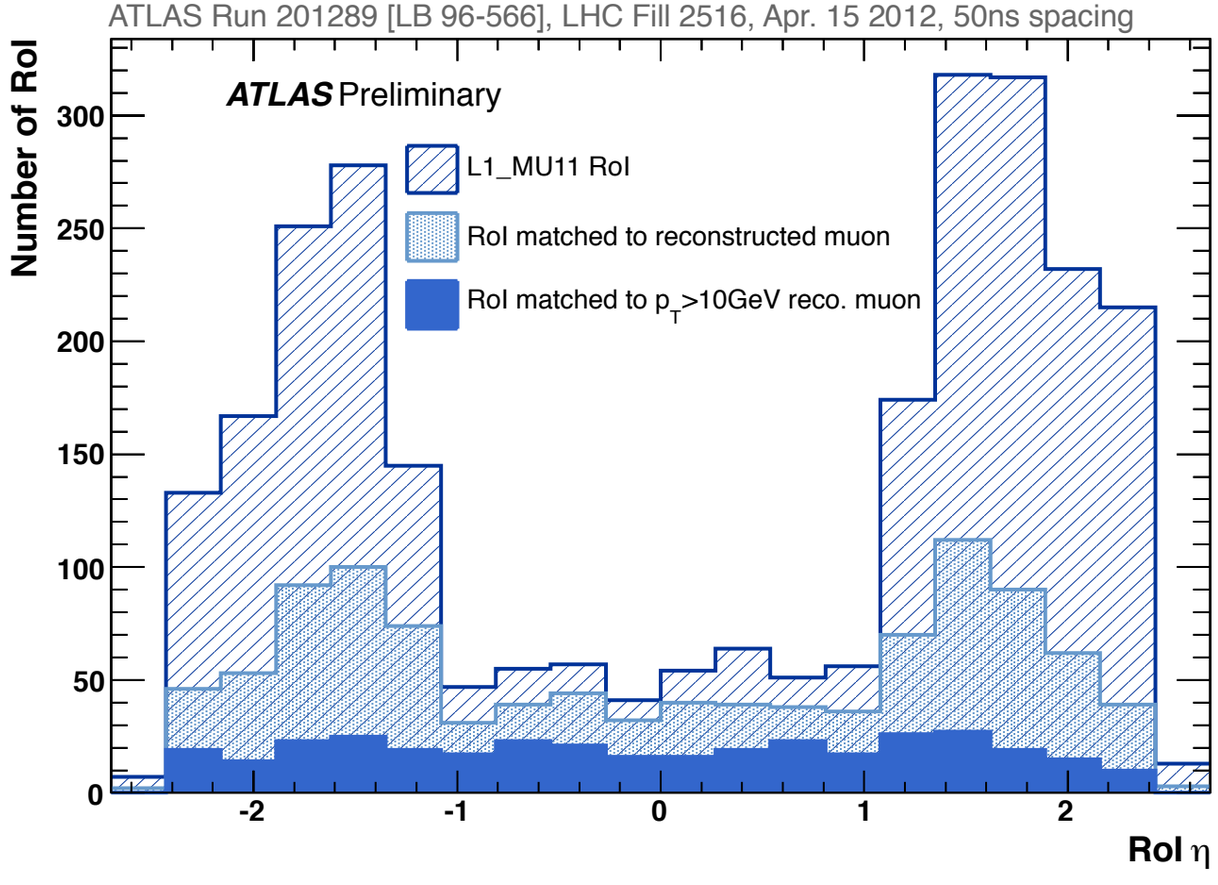
trigger

NSW adds layer of coincidence for hardware trigger decision

powerful reduction of triggers not originating from muons

emphasis of this talk



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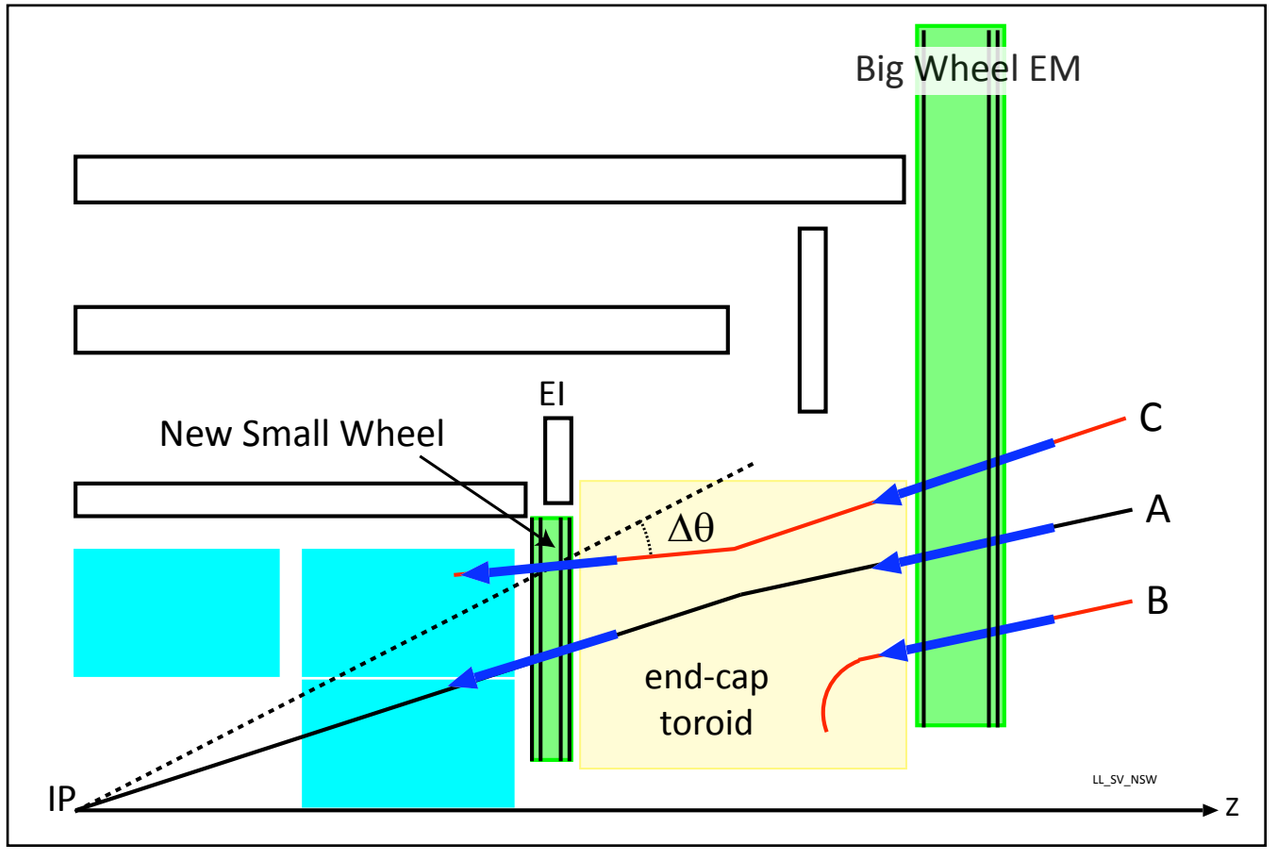
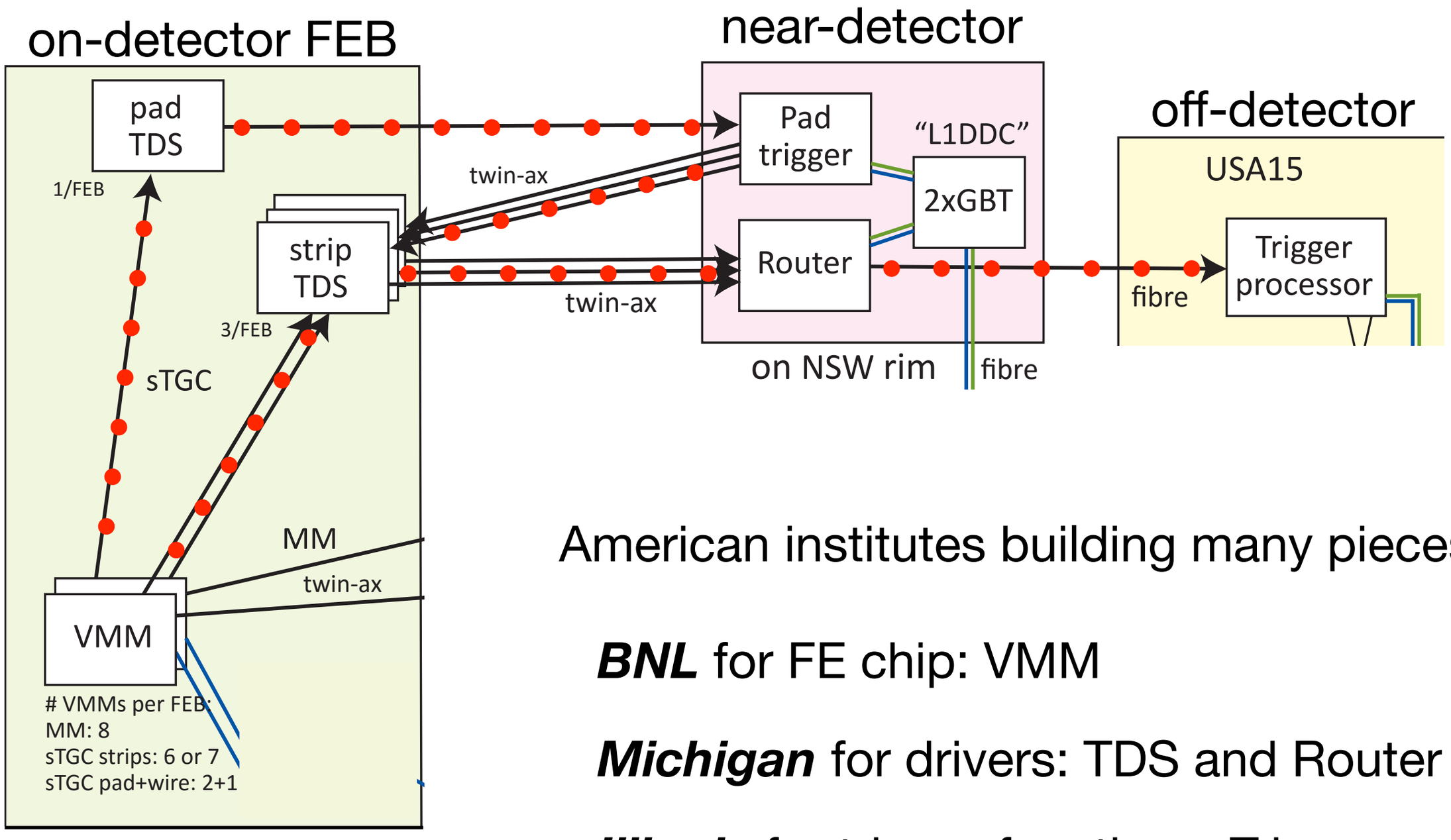


sTGC & MM triggers

sTGC trigger electronics



American institutes building many pieces!

BNL for FE chip: VMM

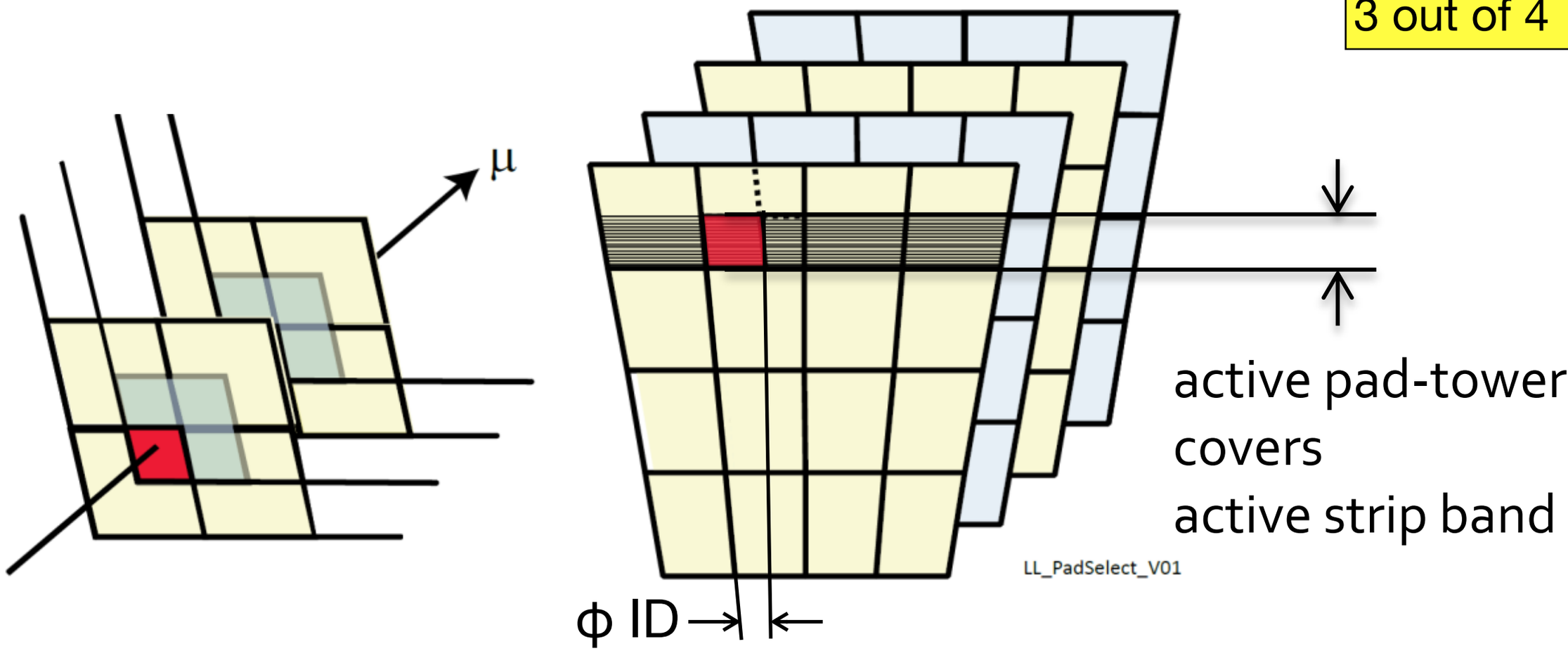
Michigan for drivers: TDS and Router

Illinois for trigger functions: Trigger anc.

sTGC trigger electronics

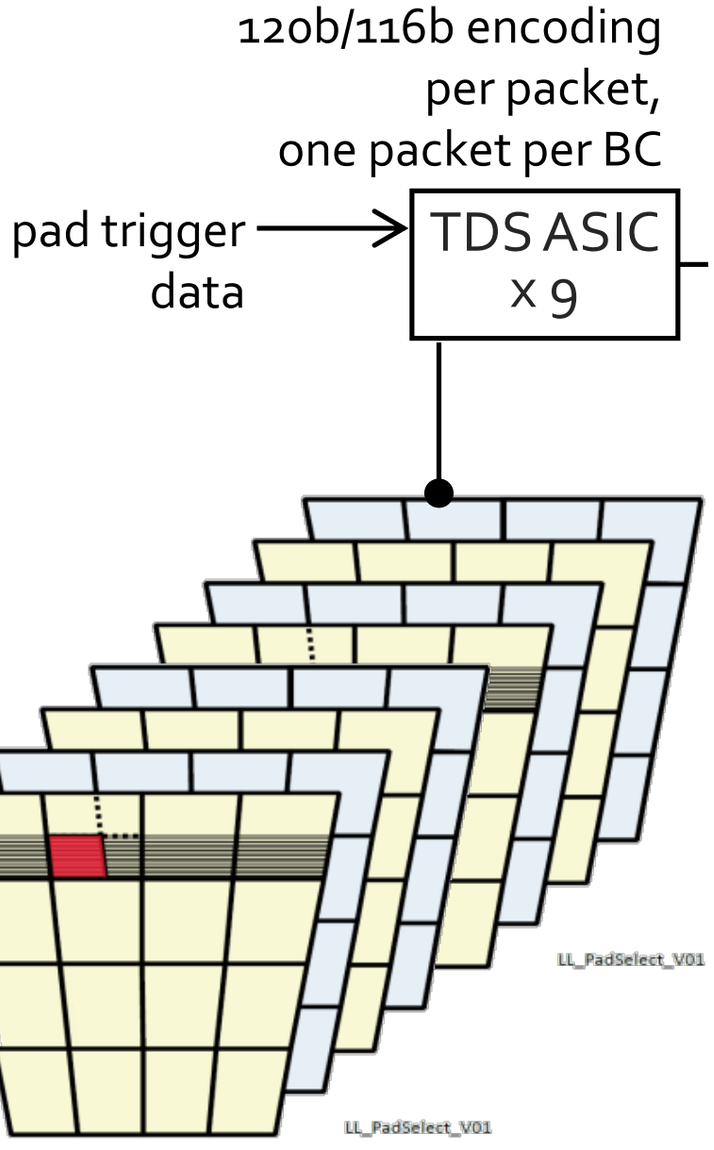
- ask for many-layer coincidence with coarse pad triggers
- readout strips within pad trigger tower

3 out of 4 &&
3 out of 4

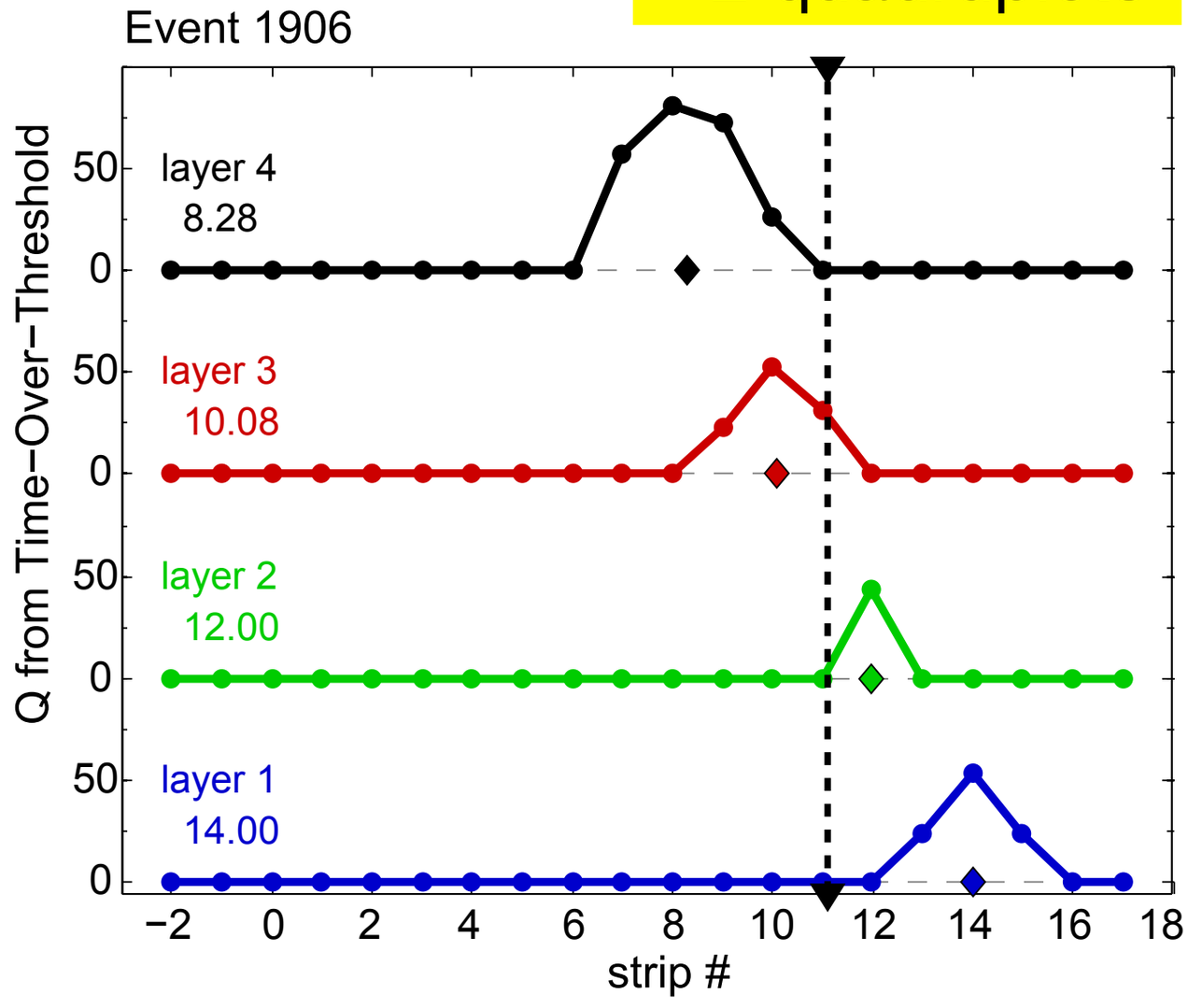


large data reduction with pad “pre-triggering”

sTGC trigger electronics



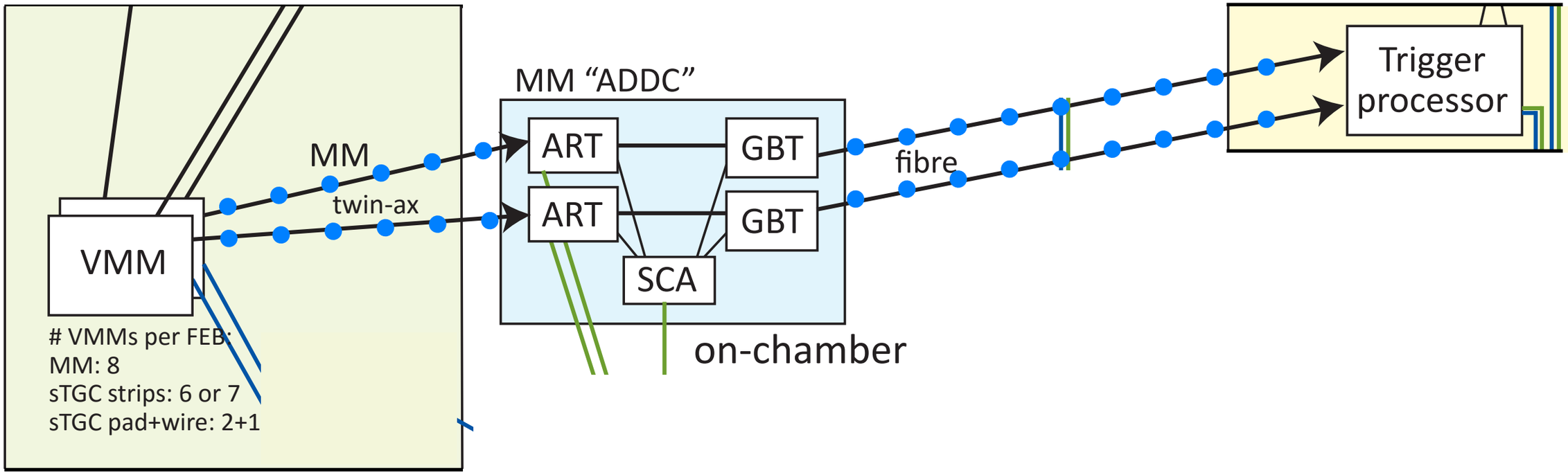
×2 quadruplets



- 8 centroids of strips
- 2 centroids of centroids
- LUT for “track”

ϕ coordinate measured by pad

MM trigger electronics



American institutes building many pieces!

BNL for FE chip: VMM

Arizona for FE card: MMFE8

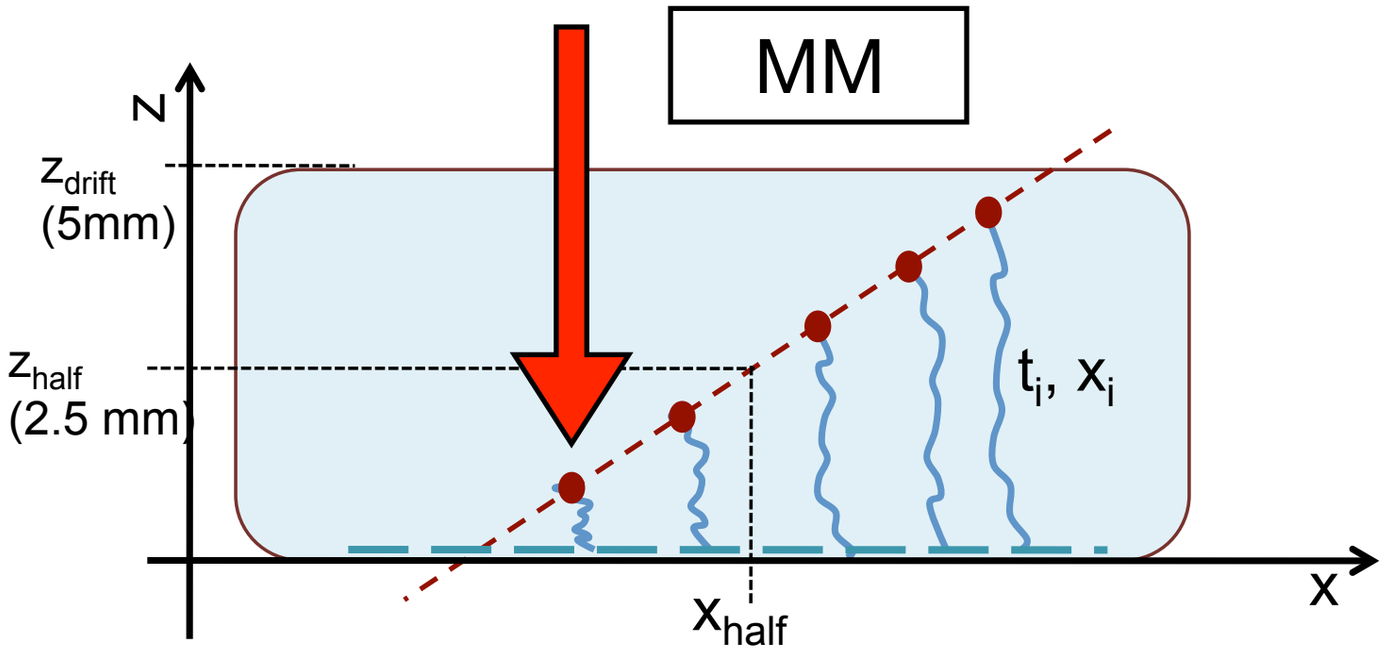
BNL for driver card: ADDC

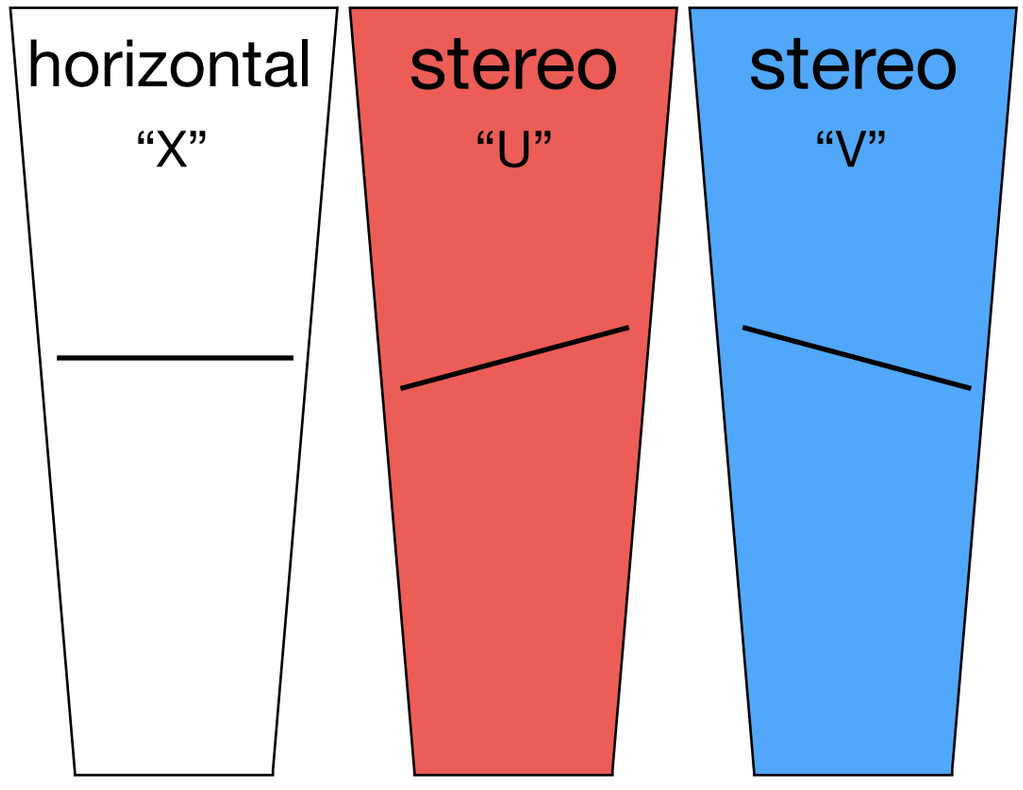
Harvard for trigger card: MM TP

Illinois for trigger functions: Trigger anc.

MM trigger electronics

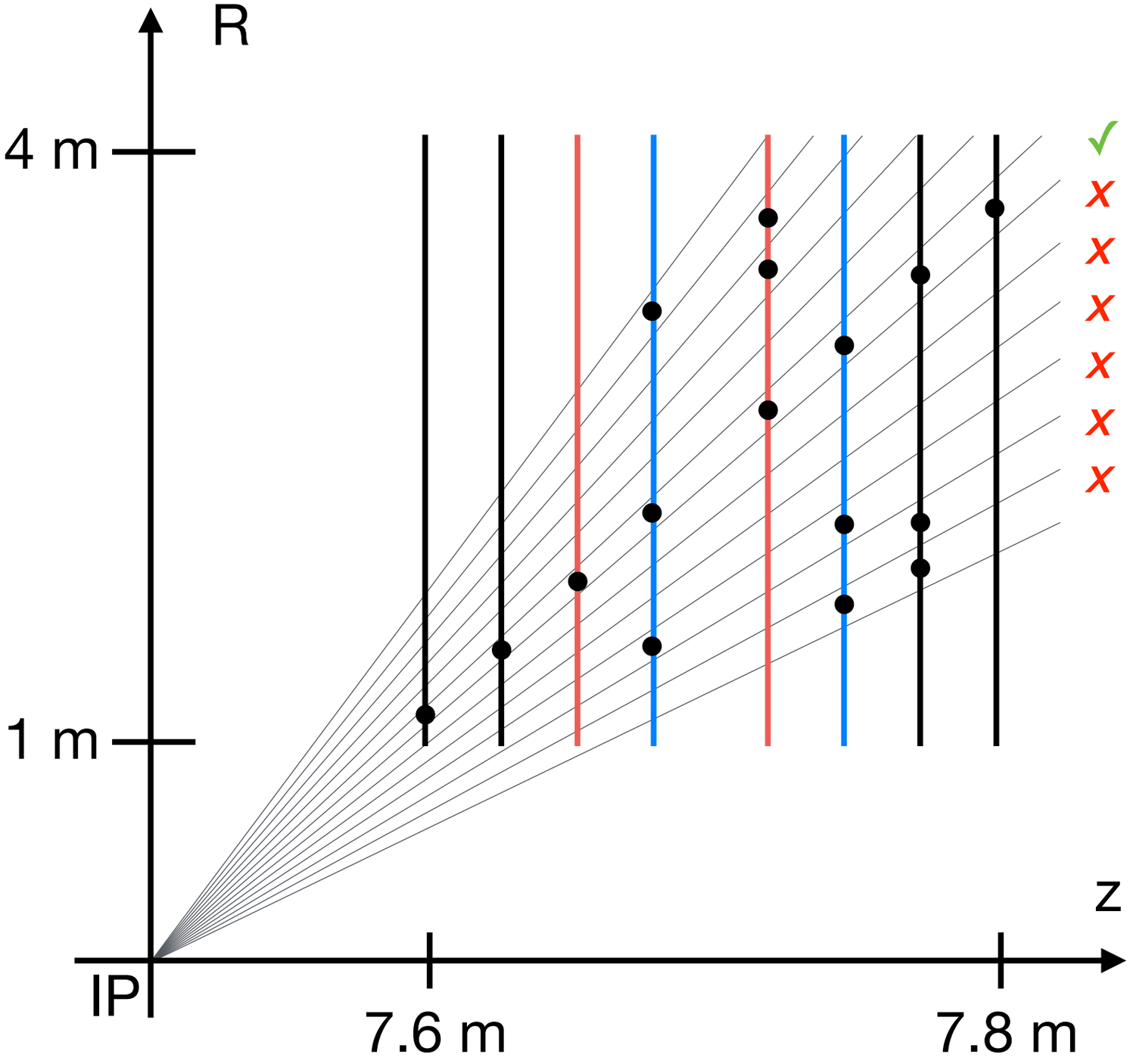
- only readout *first* strip per VMM → ~20x less data than full readout
- “ART”: Address in Real Time
- 64 strips per VMM covers ~2.5 cm





ϕ information inferred from stereo planes with θ_{strip} = 1.5°

MM trigger electronics

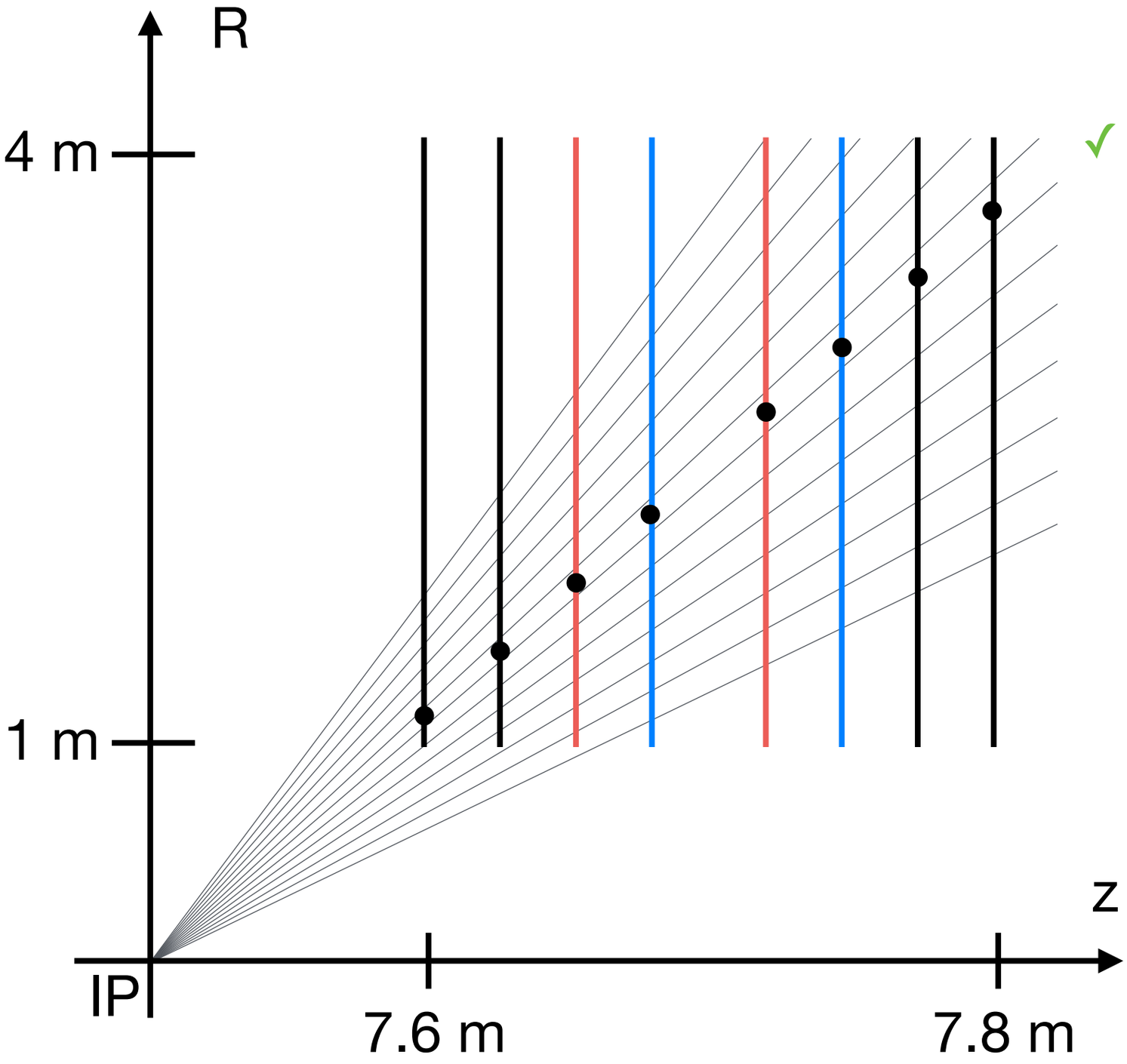


all ART strips received at MM TP, then filtered by roads in FPGA

large data reduction with road filtering:
~500 roads per chamber

filtered strips then “fit” for track parameters

MM trigger electronics



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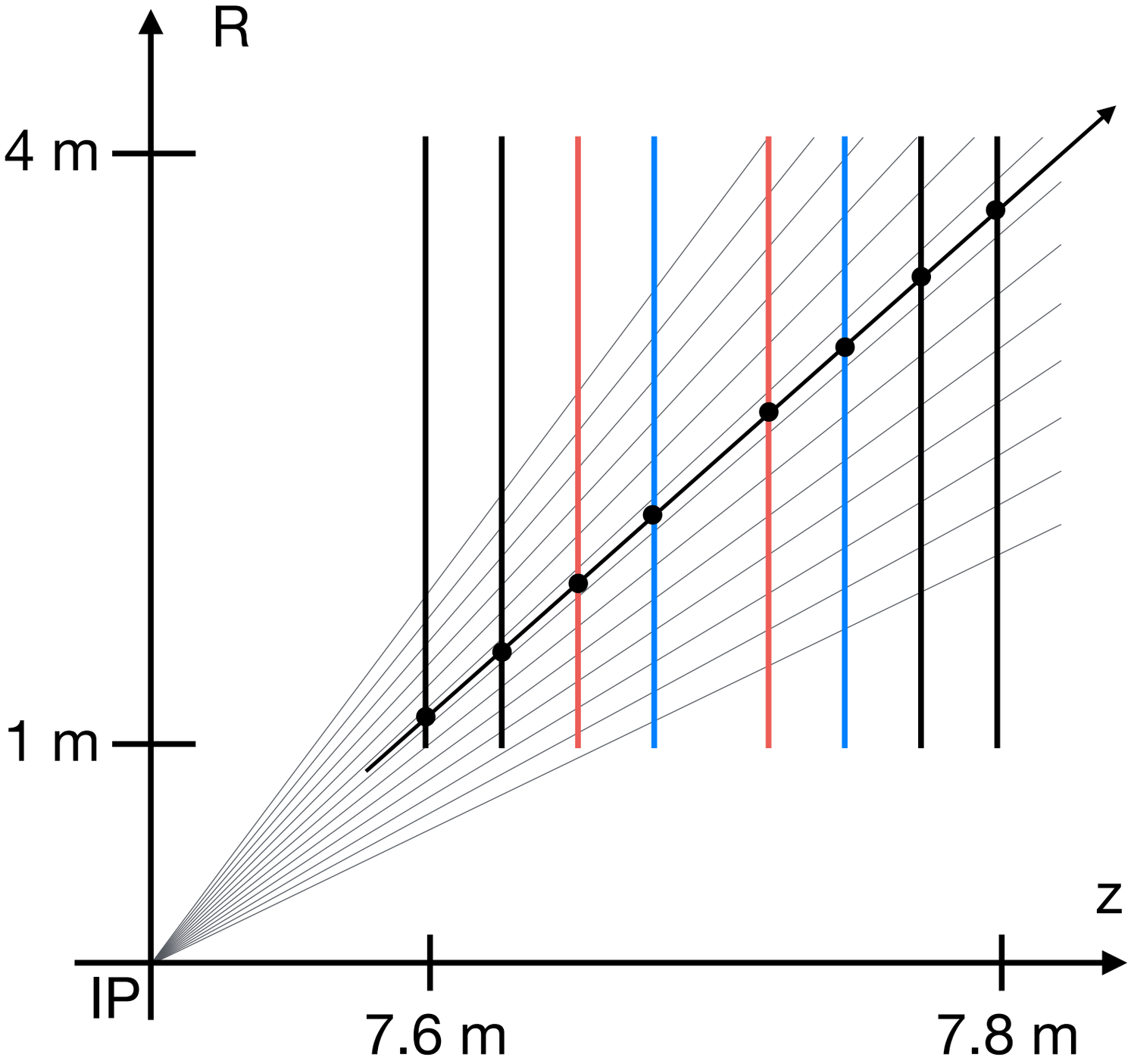


all ART strips received at MM TP, then filtered by roads in FPGA

large data reduction with road filtering:
~500 roads per chamber

filtered strips then “fit” for track parameters

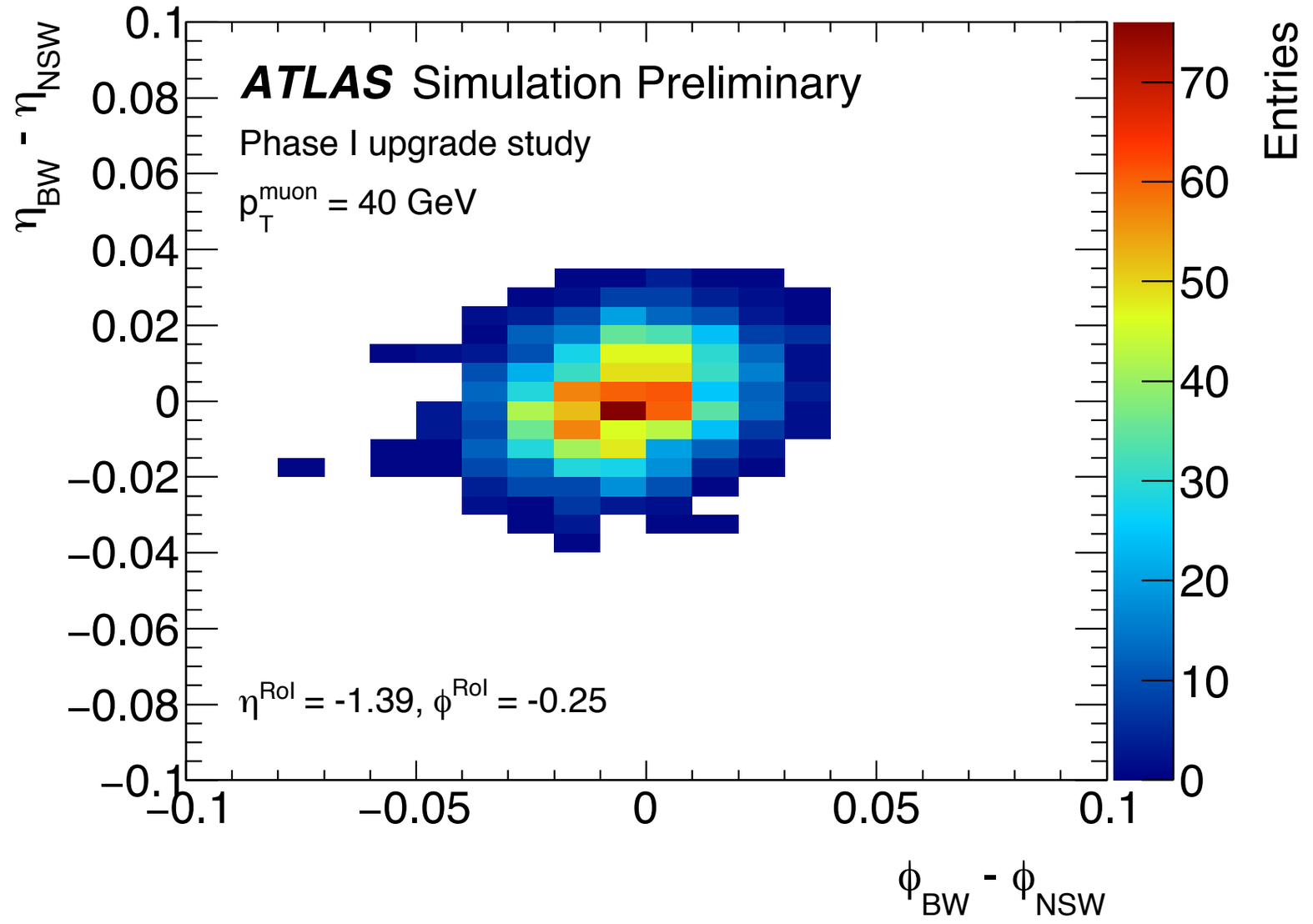
performance

simulated performance

simple OR of sTGC and MM decisions

excellent matching resolution between NSW and existing BW

NSW-BW coincidence efficiency expected to be 90-95% or better for flagship L1 $p_T(\mu) > 20$ GeV

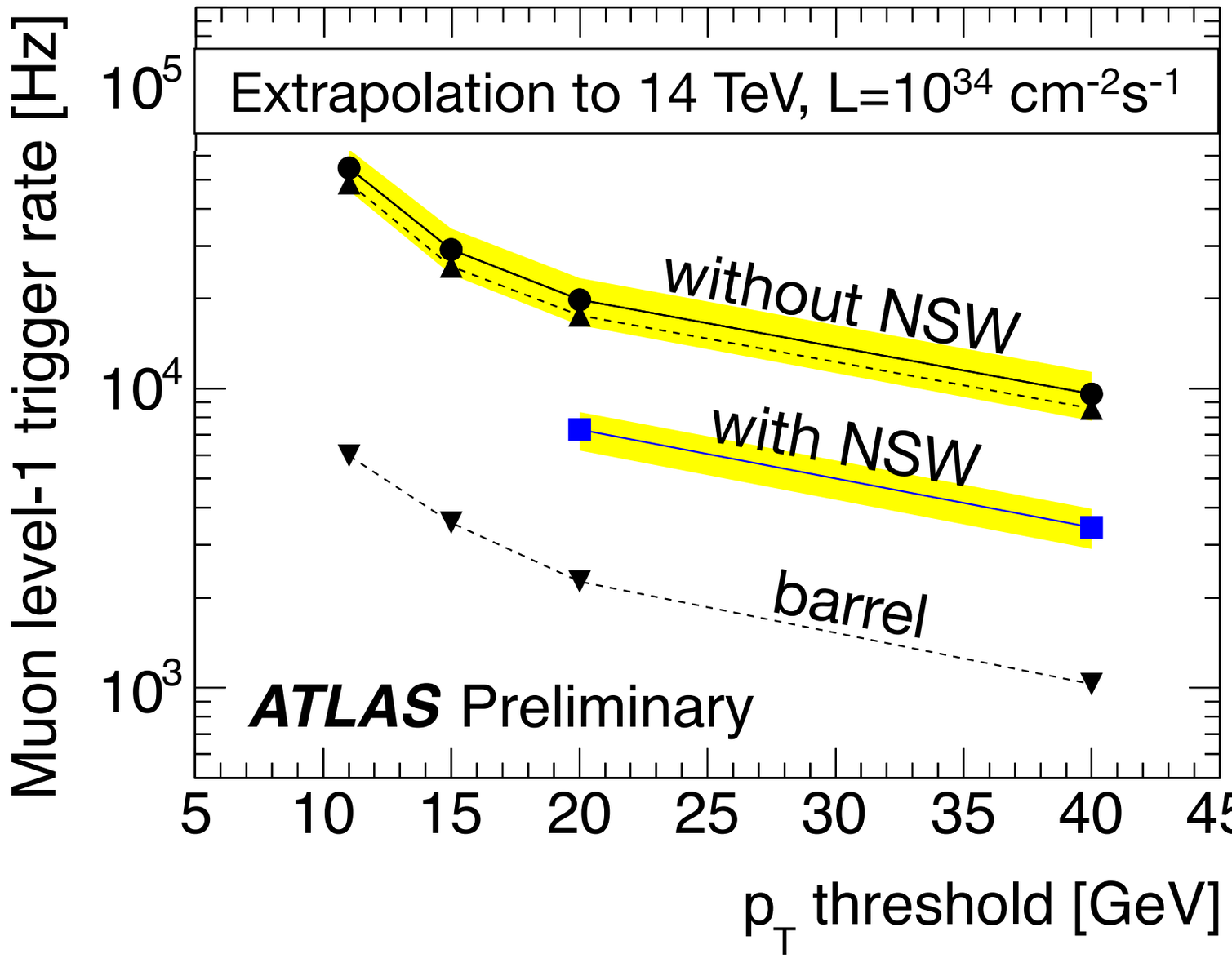


simulated performance

simple OR of sTGC and MM decisions

muon trigger rates
dominated by fakes
in the endcaps

substantial rate
reduction (~3x)
predicted with NSW

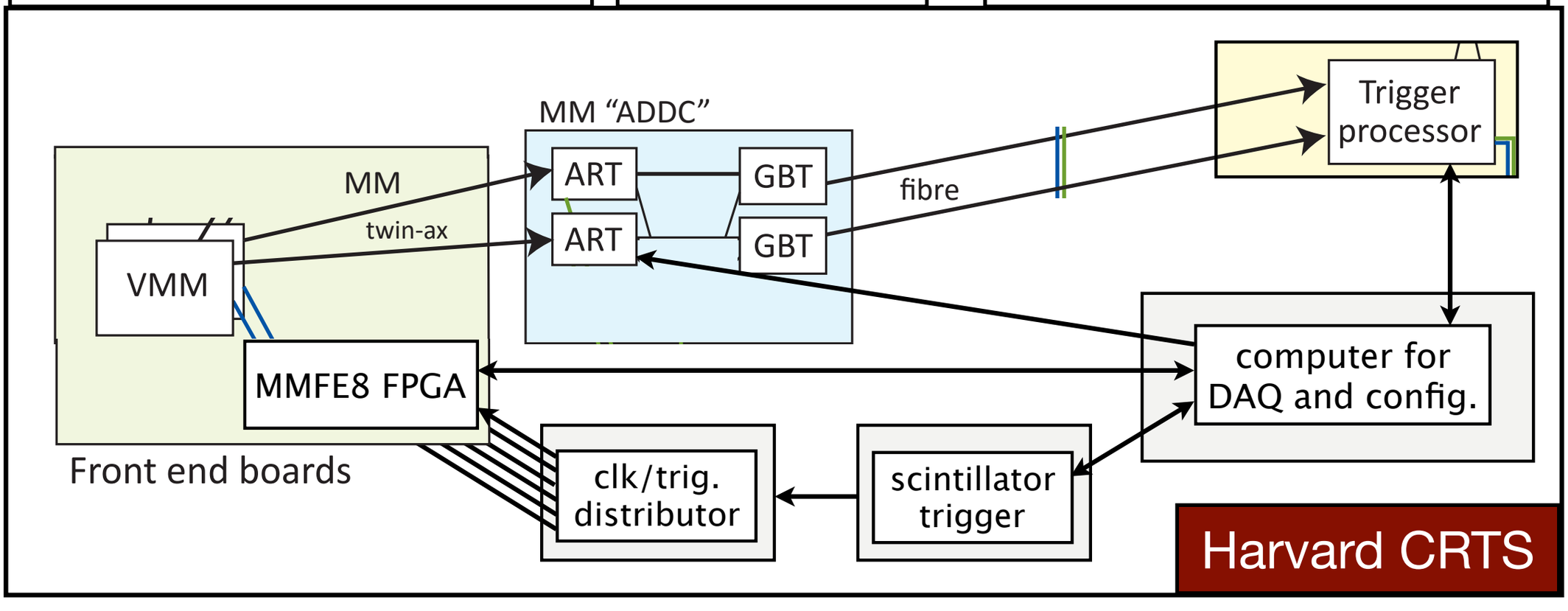


MM performance in data!

built 8-layer micromegas mini-chamber at Harvard to measure performance with cosmic ray muons

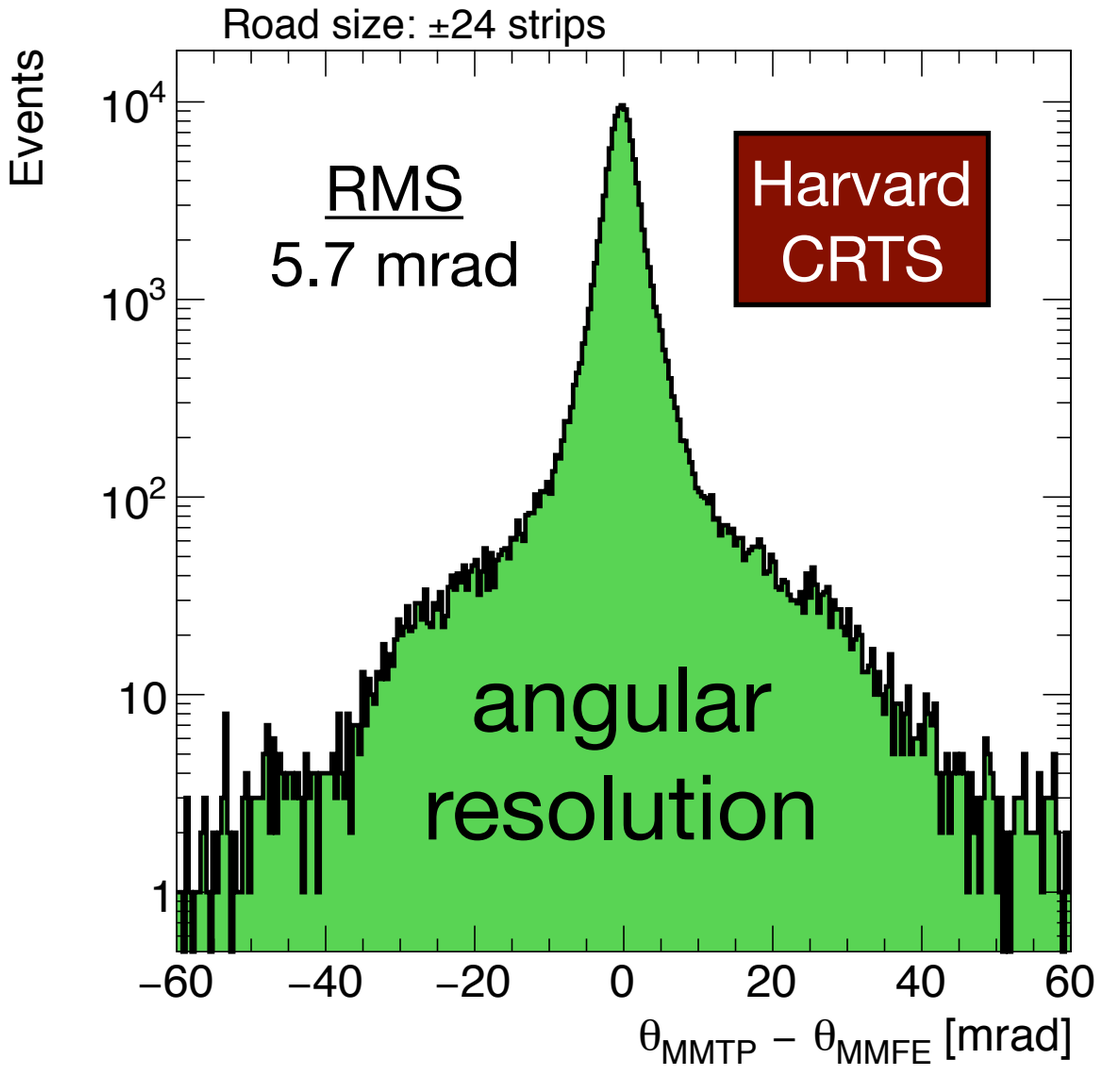
chamber equipped with prototype electronics, and recording both trigger and offline data

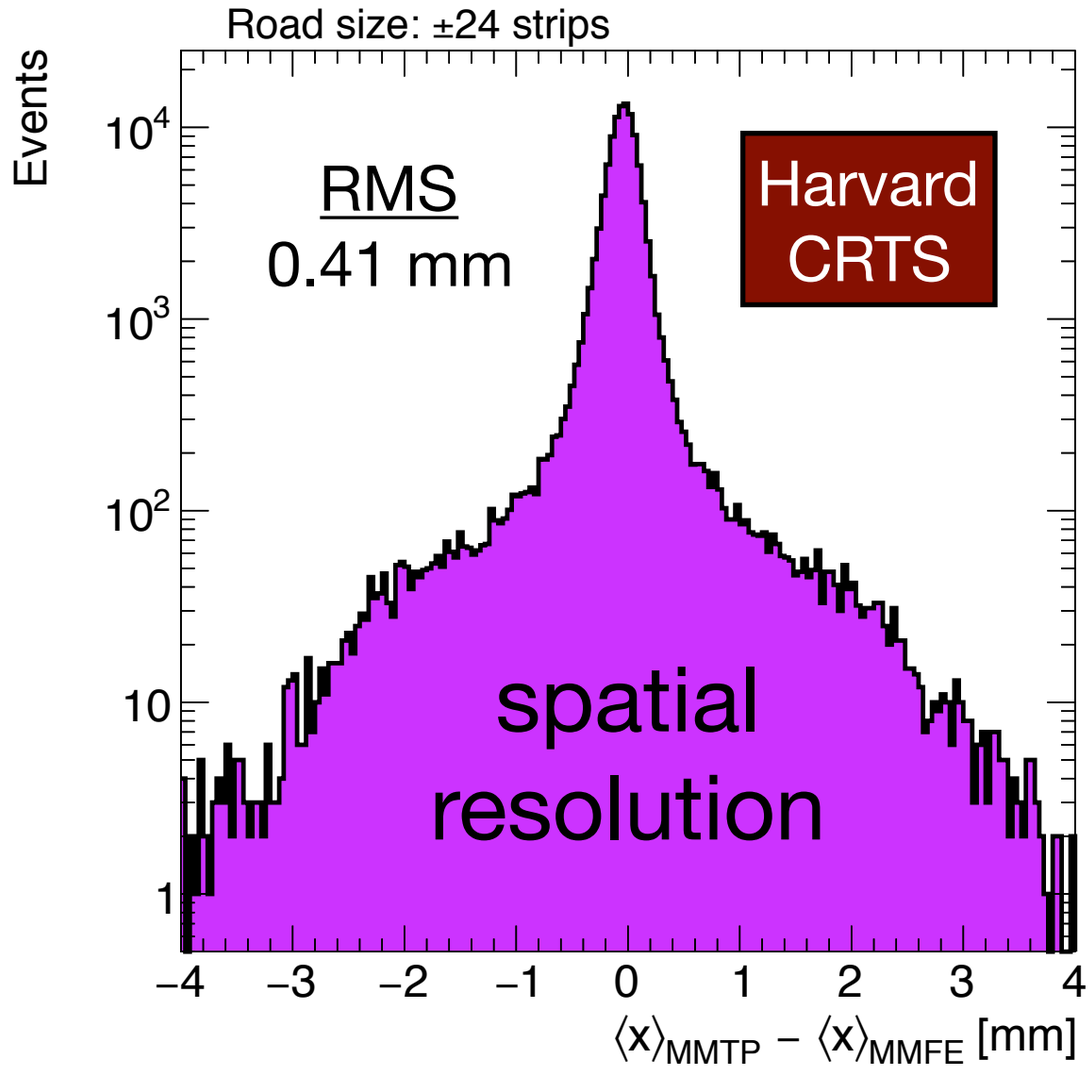
MMFE8s w/VMM2 | ADDC V1 | MMTP on VC707



MM cosmic ray test stand

taking offline (full) readout as reference,
trigger algorithm fully functioning and performs within spec

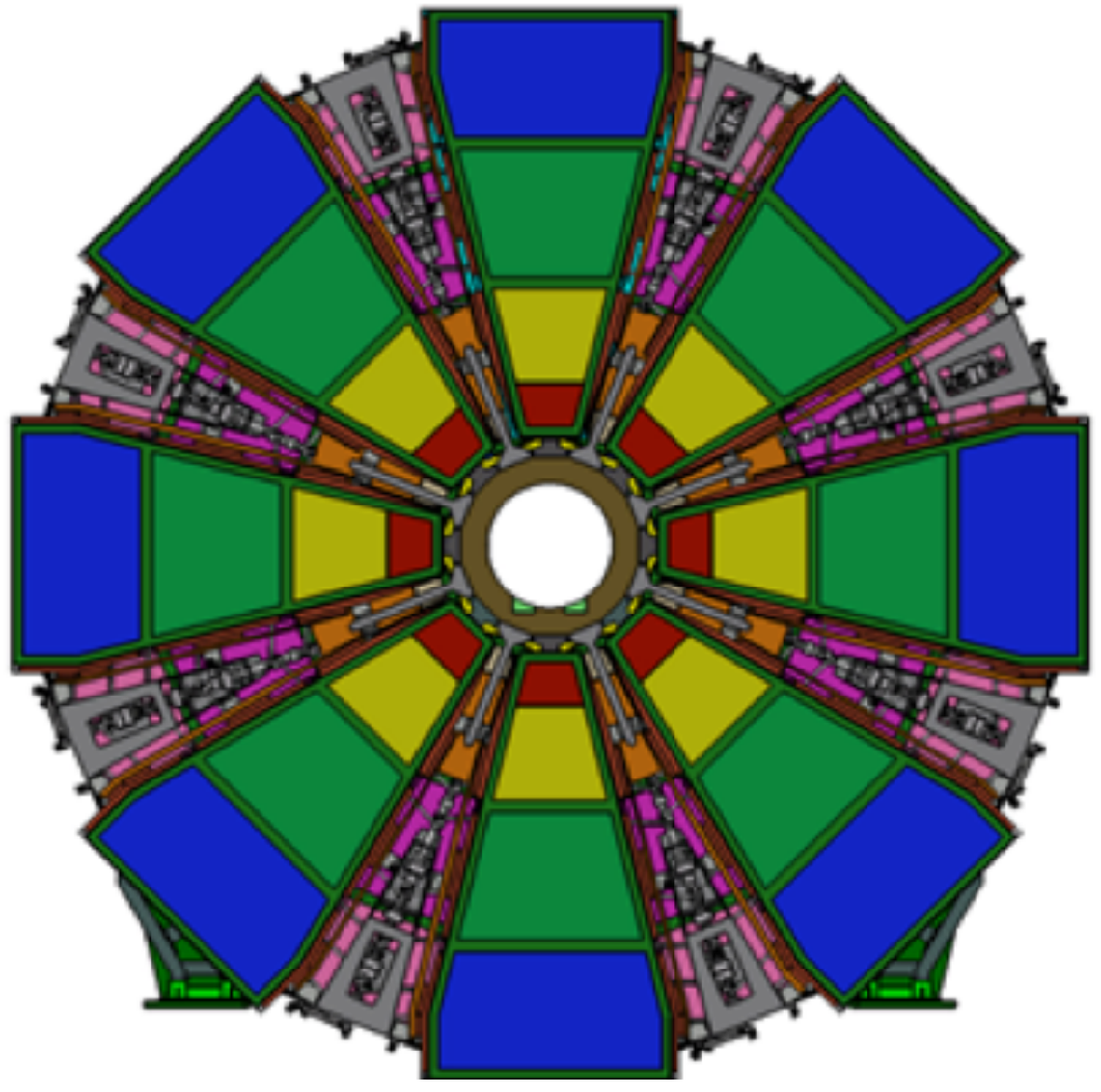




summary

summary

New Small Wheel (NSW)
is under construction now,
planned to be operational for
Run 3 of the LHC and beyond



NSW trigger hardware and
algorithms in advanced state,
already making triggers with
cosmic ray muons

bonus

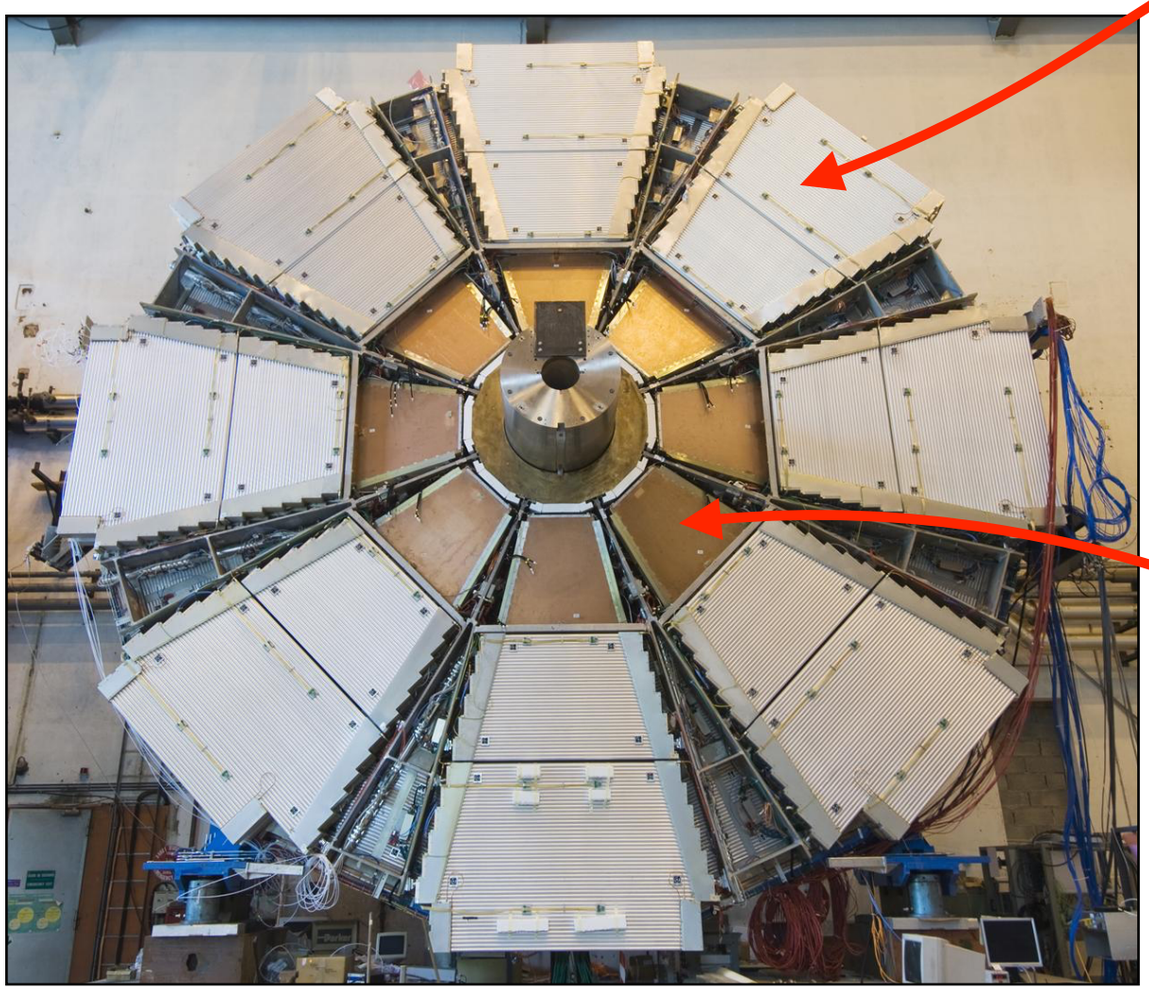
some references

New Small Wheel Technical Design Report	https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/UPGRADE/CERN-LHCC-2013-006/index.html
Muon Spectrometer Technical Design Report	http://atlas.web.cern.ch/Atlas/GROUPS/MUON/TDR/Web/TDR.html
NSW Public Results	https://twiki.cern.ch/twiki/bin/view/AtlasPublic/NSWPublicResults
L1 Muon Public Results	https://twiki.cern.ch/twiki/bin/view/AtlasPublic/L1MuonTriggerPublicResults
Muon Trigger Public Results	https://twiki.cern.ch/twiki/bin/view/AtlasPublic/MuonTriggerPublicResults

the current Small Wheel (SW)

innermost layer of ATLAS muon spectrometer endcap

not built to withstand HL-LHC!



Monitored Drift Tubes (MDT)

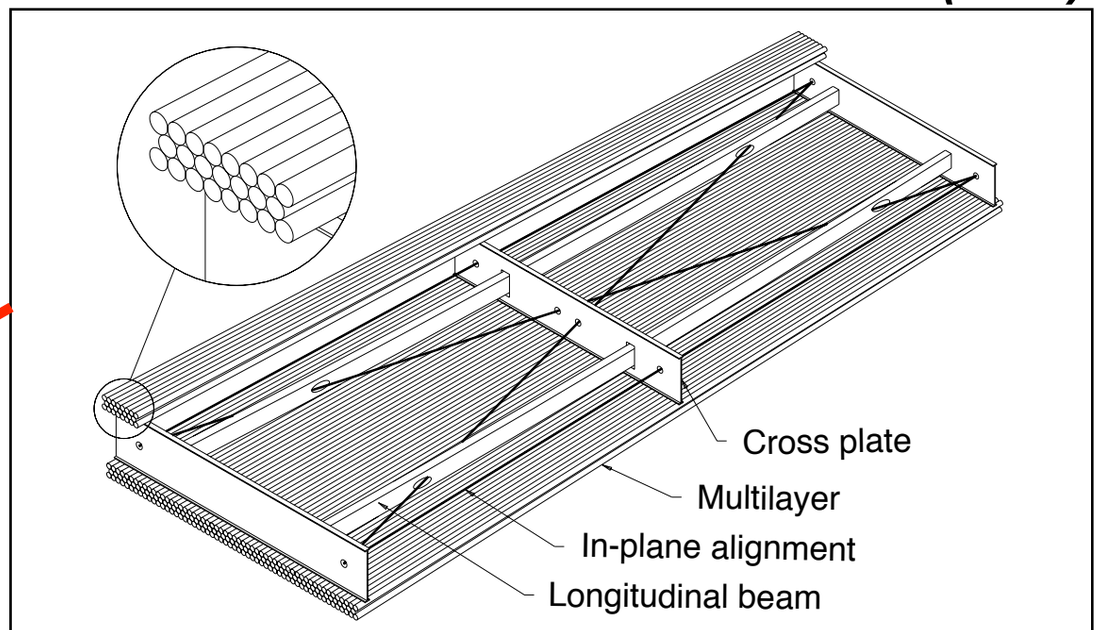


Figure 1-9 Schematic drawing of a rectangular MDT chamber constructed from multilayers of three monolayers each, for installation in the barrel spectrometer. The chambers for the end-cap are of trapezoidal shape, but are of similar design otherwise.

Cathode Strip Chambers (CSC)

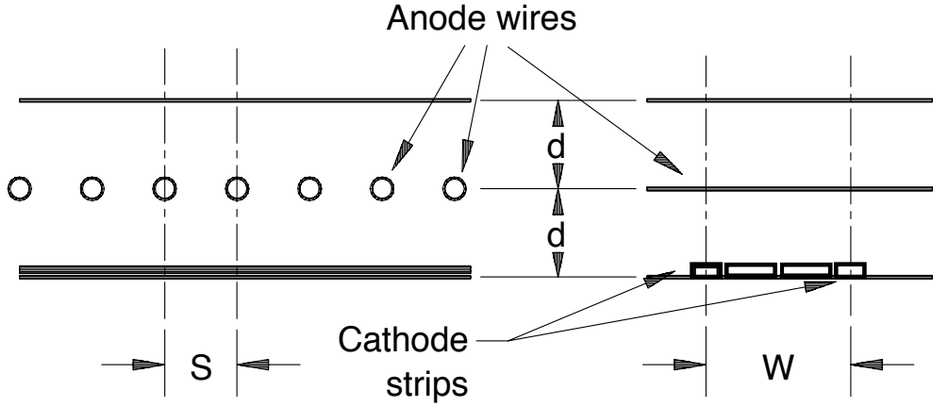
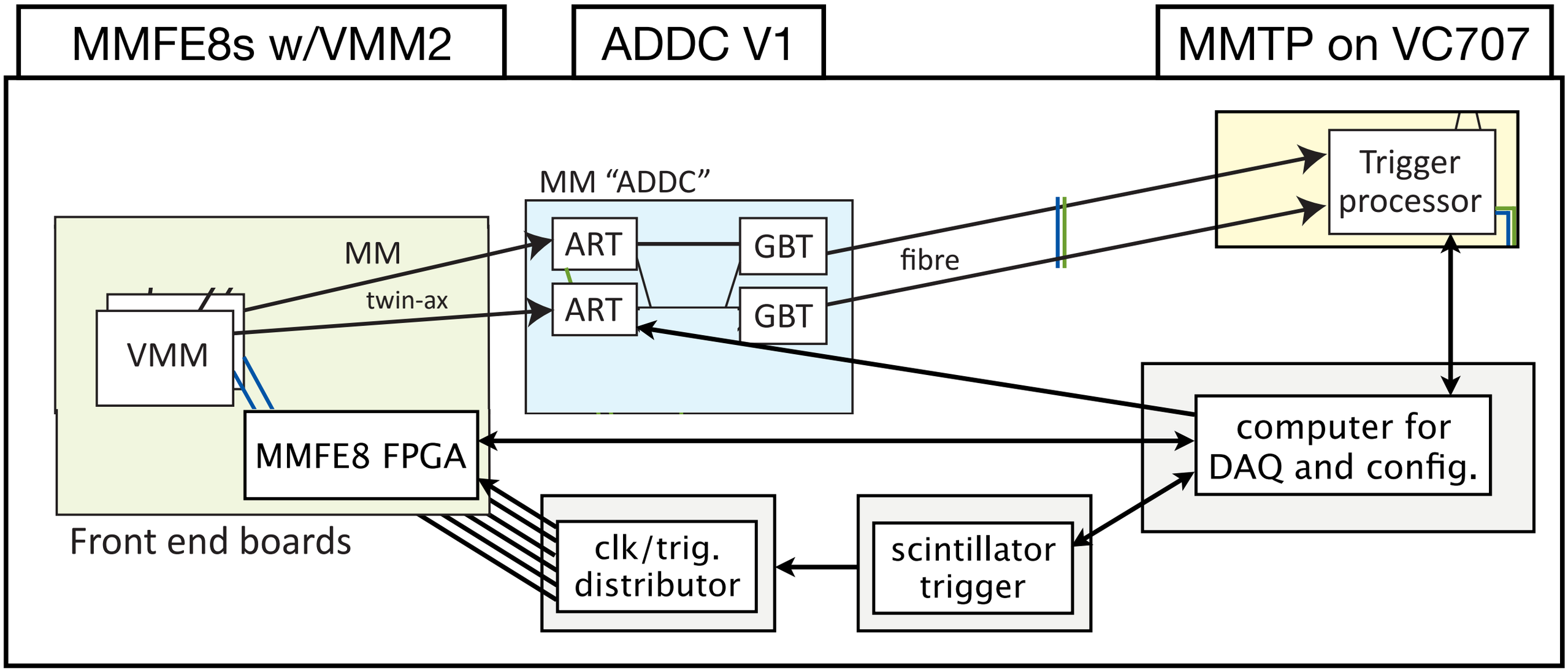


Figure 1-10 Schematic diagram of the Cathode Strip Chamber

reminder: Harvard test stand



collected a few 100k cosmic muons
with low noise in May

Overview at last Muon Week